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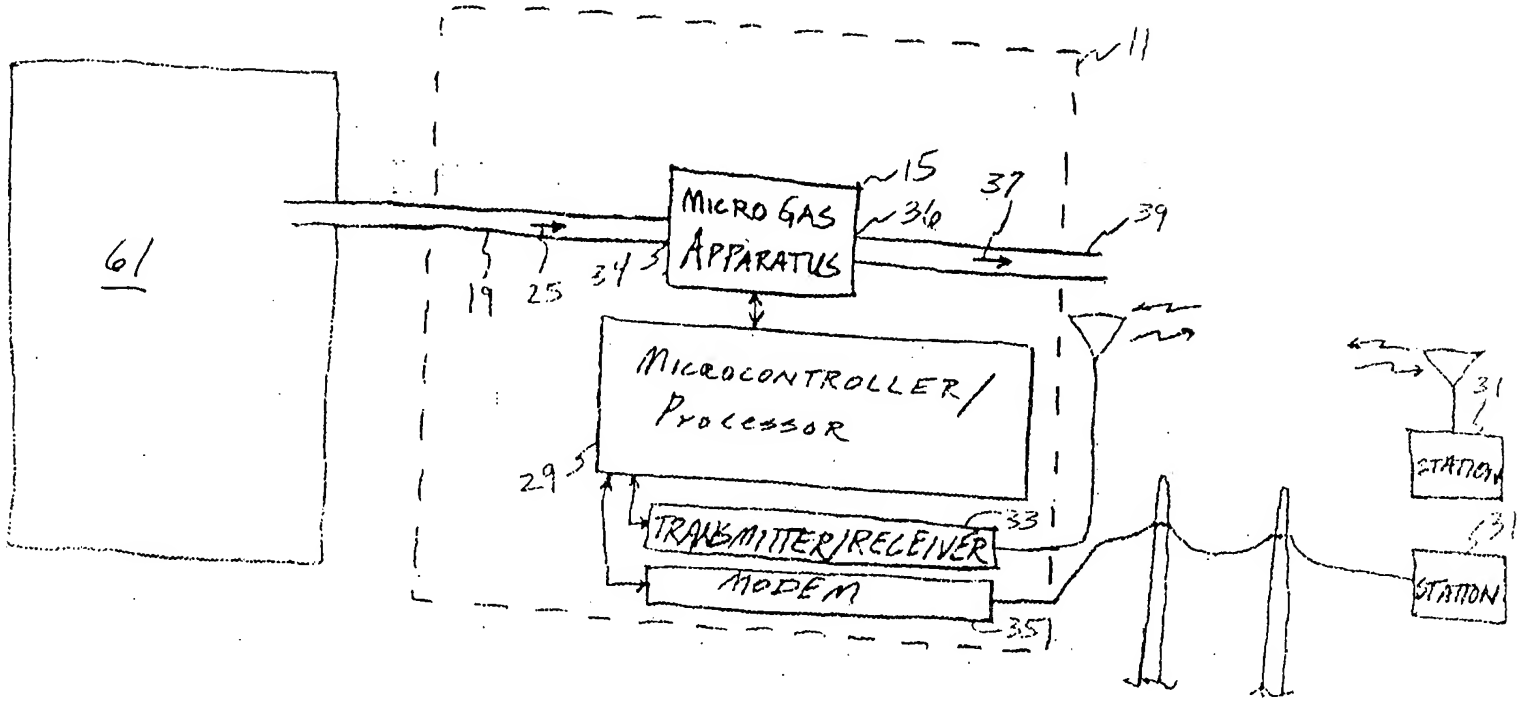

11
61
MICRO GAS APPARATUS
15
36
37
39
34
19
25
MICROCONTROLLER/ PROCESSOR
29
TRANSMITTER/RECEIVER
33
MODEM
35
31
STATION
31
STATION

FIGURE 1

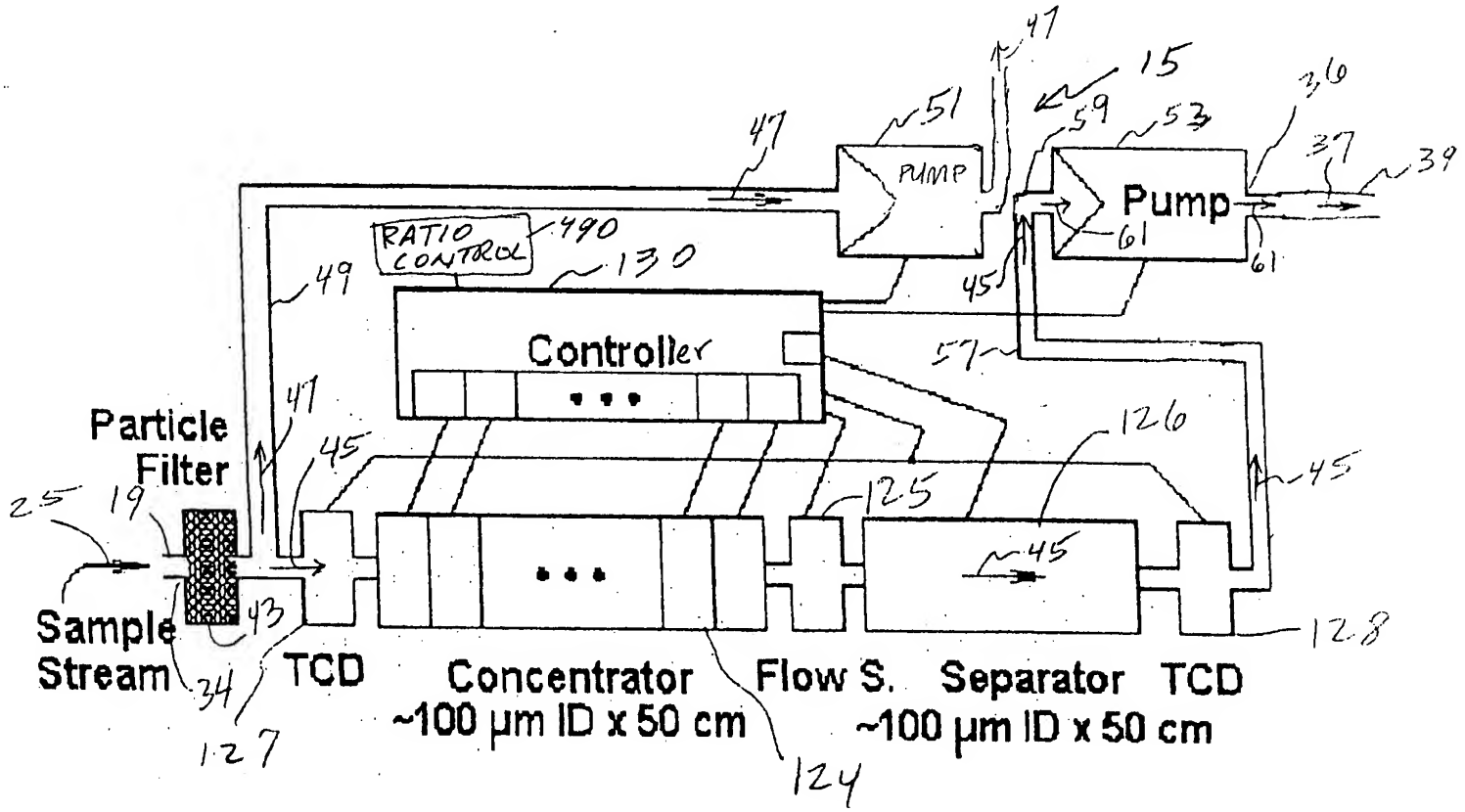

47
15
51
59
53
36
37
39
PUMP
Pump
61
61
RATIO CONTROL
490
130
49
45
Controller
57
47
Particle Filter
45
126
45
25
19
125
45
43
Sample Stream
34
TCD
Concentrator
~100 µm ID x 50 cm
Flow S.
Separator
~100 µm ID x 50 cm
TCD
128
127
124

FIGURE 2

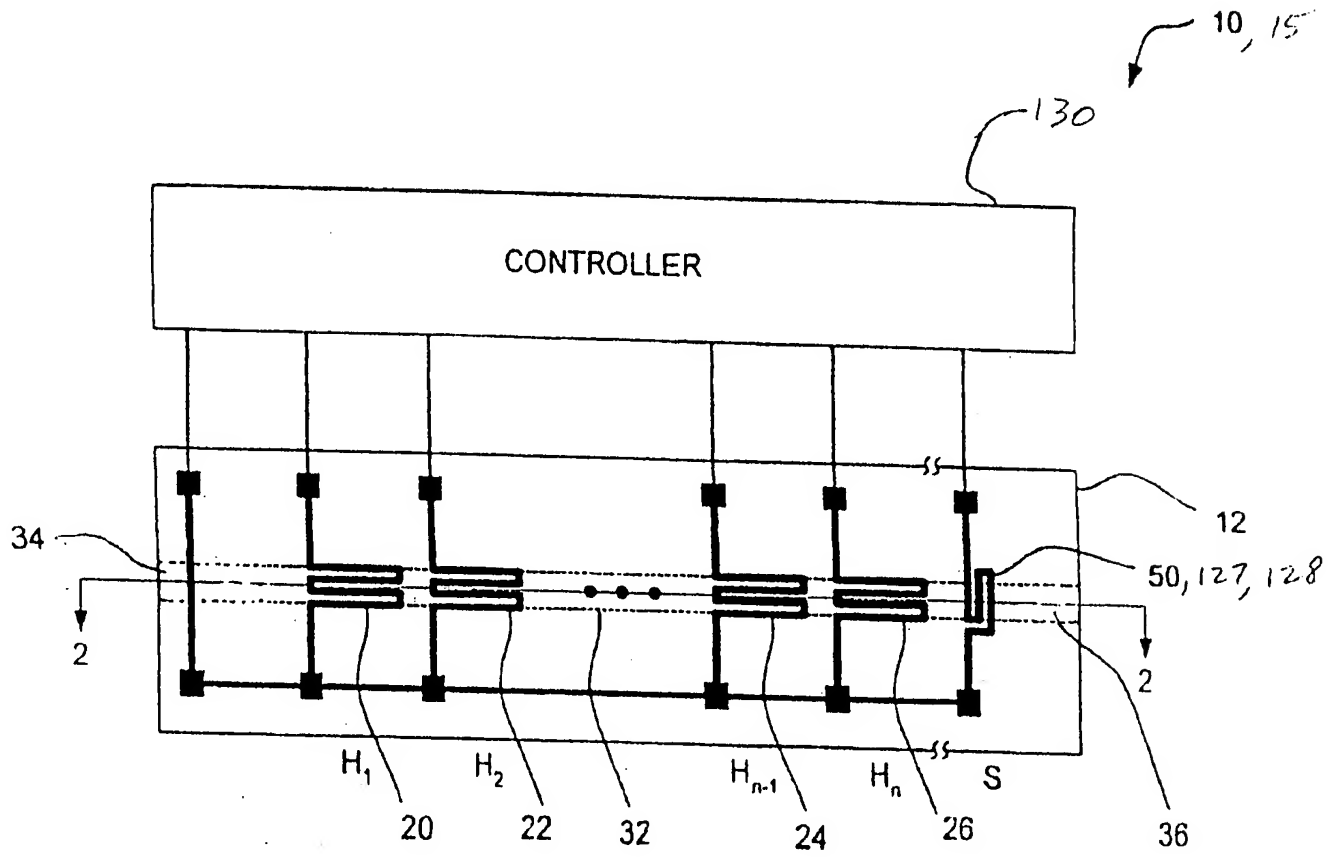

10, 15
130
CONTROLLER
12
34
50, 127, 128
2
2
H_1
H_2
H_{n-1}
H_n
S
20
22
32
24
26
36

FIGURE 3

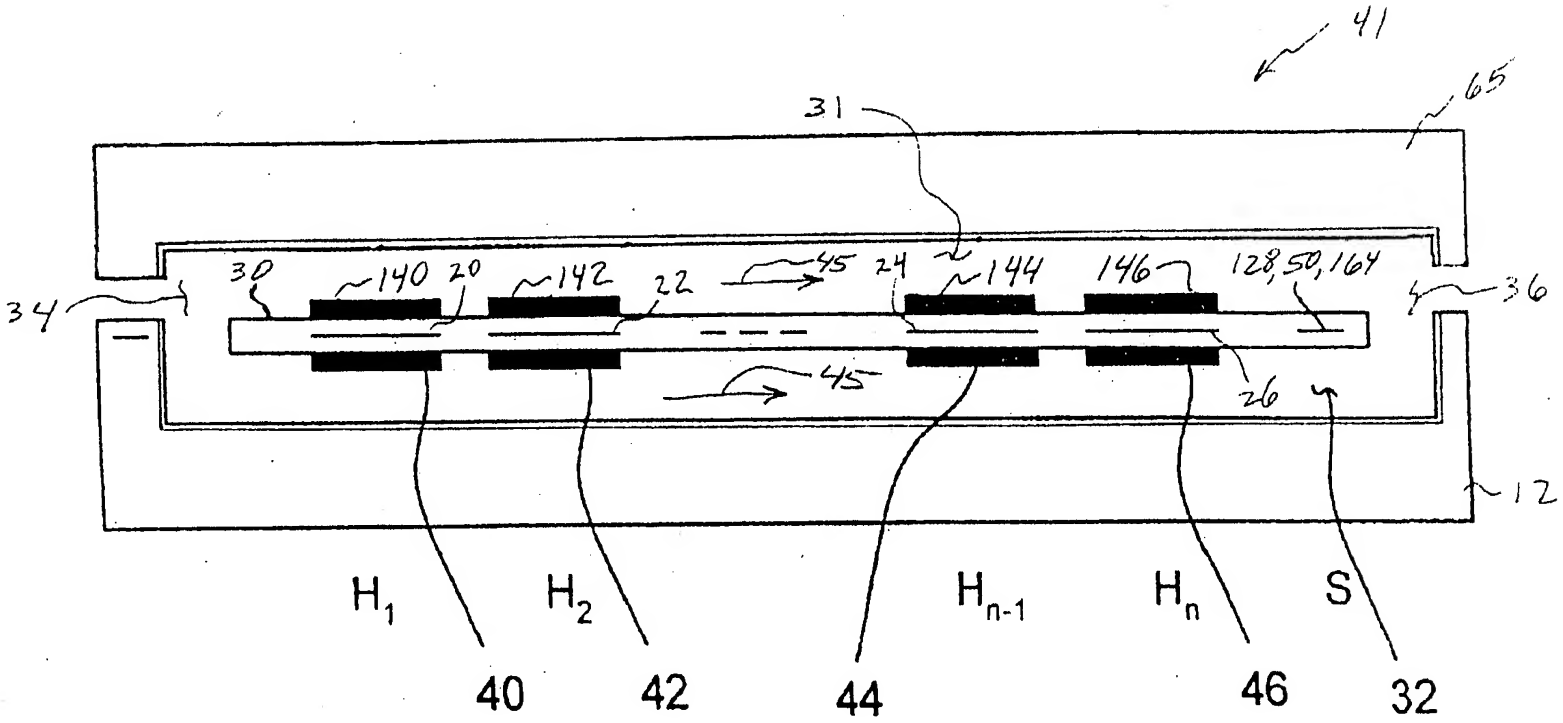

41
65
31
30
140
20
142
22
45
24
144
146
128,50,164
34
36
45
26
12
H_1
H_2
H_{n-1}
H_n
S
40
42
44
46
32

FIGURE 5

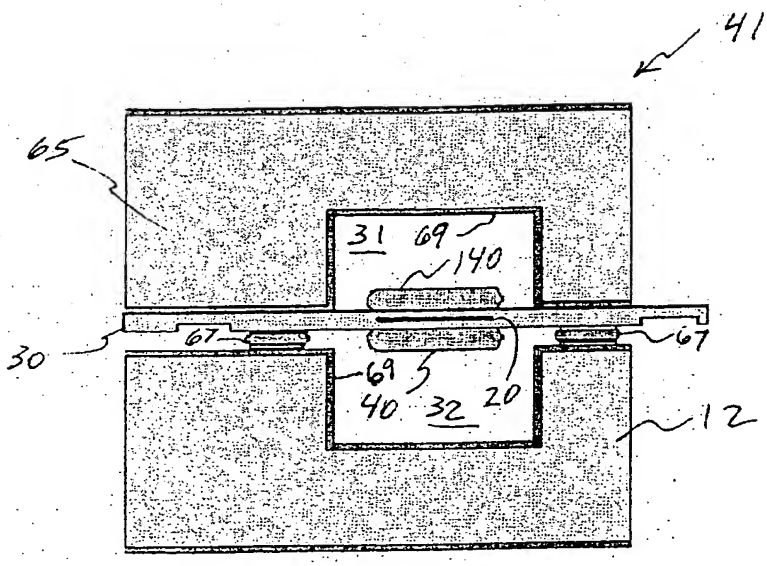


FIGURE 6a

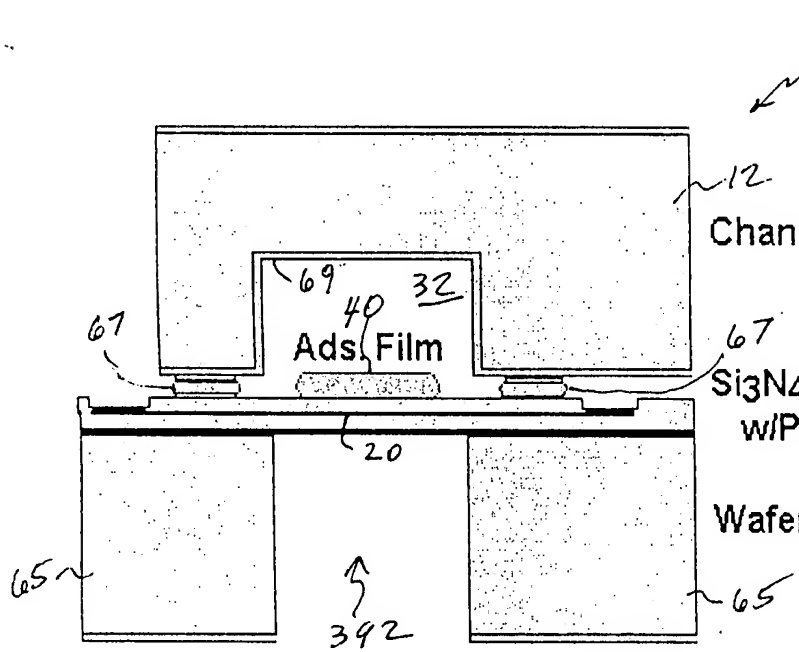


FIGURE 6b

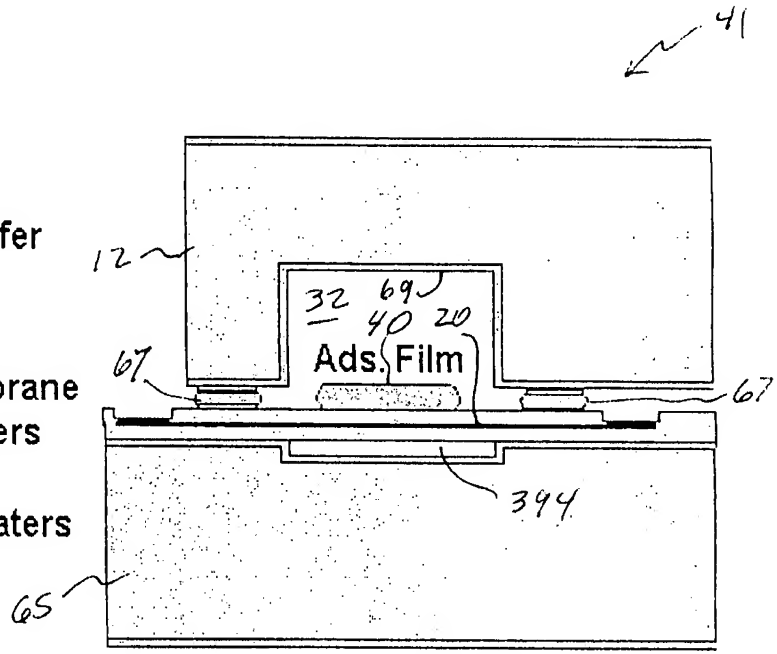


FIGURE 6c

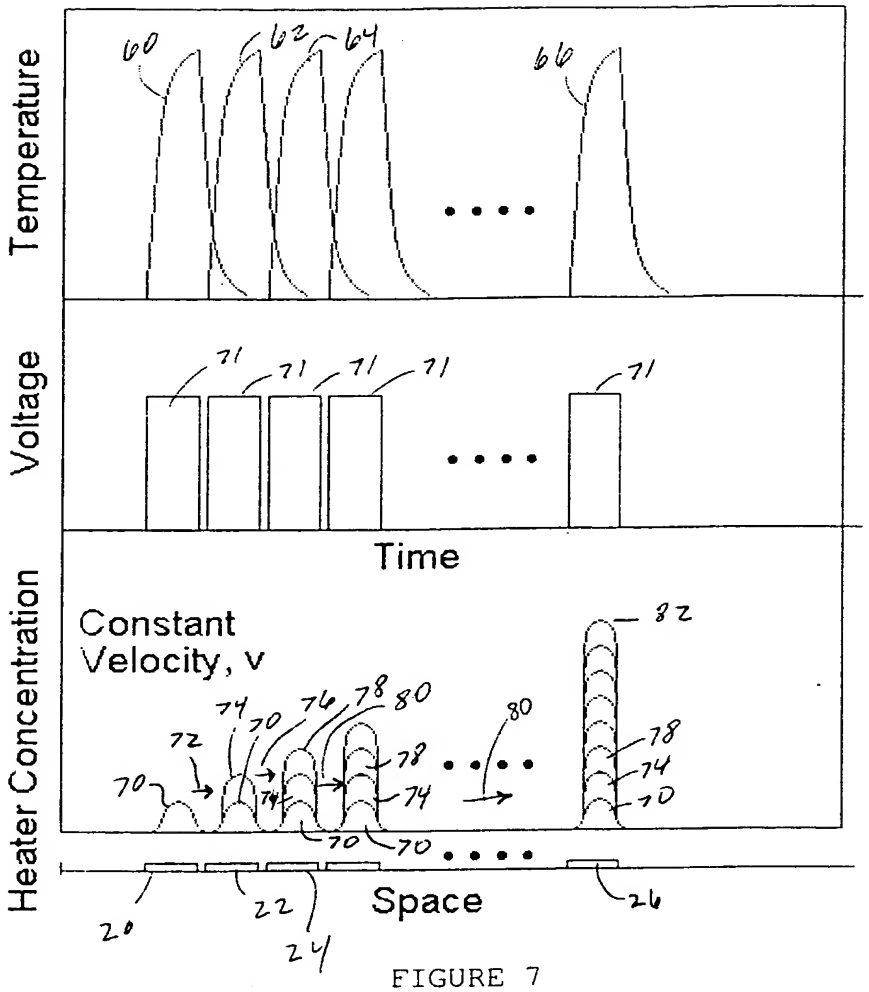

Temperature
60
62
64
66
Voltage
71
Time
Heater Concentration
Constant
Velocity, v
72
70
74
76
78
80
82
Space
20
22
24
26

FIGURE 7

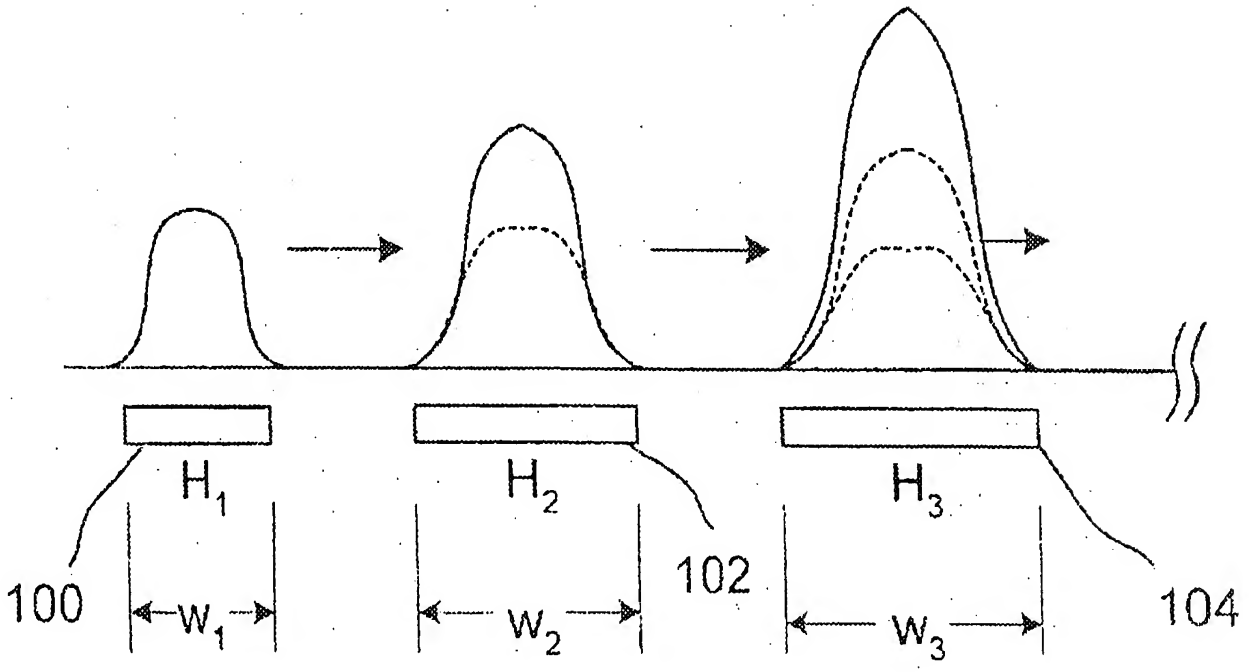


FIGURE 8

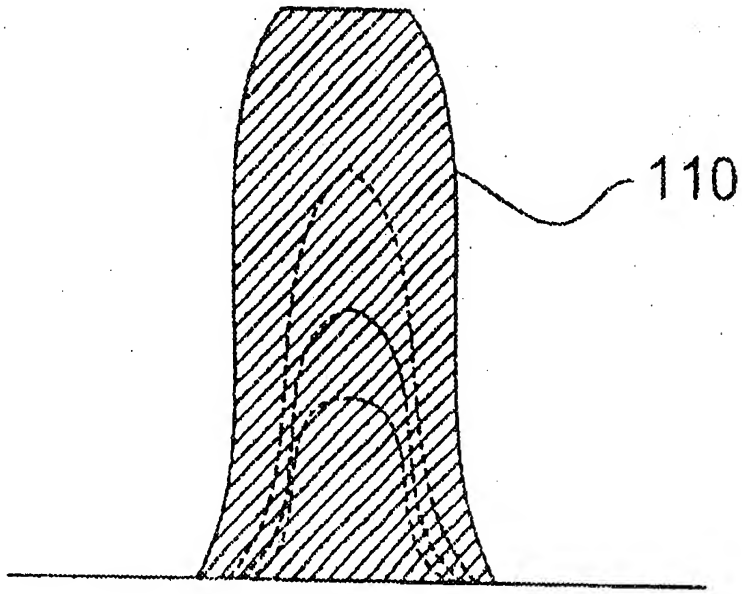


FIGURE 9

FIGURE 10

Comparison of Detection Limits in pg/s (MDL) and Selectivities × 10^3 (SEL)

element	wavelength, nm	this work		ref 9 (without background correction)		ref 9 (with background correction)		ref 7[c] (echelle)		ref 8[b] (with background correction)	
		MDL	SEL	MDL	SEL	MDL	SEL	MDL	SEL	MDL	SEL
N	174.2	7.0	6								
S	180.7	1.7	350								
Hg	184.9	0.1	3000								
C	193.1	0.5									
P	177.5	1.5	25							53	
C	247.9	2.6		2.7							
S	251.6	7.6	90	9.5	1.6			58	3.9		
P	253.6			3.9	11			4.2	26		
Hg	253.7	0.1	5000	0.6	77			2.0	91		
Br	470.4			33	0.27	67	1.0	20	1.4	38	0.53
Br	478.6	75	19	34	0.60						
Cl	479.5	39	25	43	0.61	86	1.5			32	1.0
Cl	481.0							32	2.4		
H	486.1	2.2		16							
S	545.4	7.2	26	33	0.08	52	4.6	126	0.25	204	0.07
D	656.1	2.5	0.6[c]	7.4	0.19						
H	656.3	3.0		7.5						37	
F	685.6	40	30	20	0.57	180	11.4	17	3.5	11	0.52
O	777.2	75	25								

[a]Reference 7 uses peak width at base instead of peak width at half height to determine MDL, and the numbers have been adjusted accordingly for comparison. [b]Reference 8 uses 1σ instead of peak to peak 16σ to measure noise for MDL, and their numbers have been adjusted accordingly for comparison. [c]Versus hydrogen.

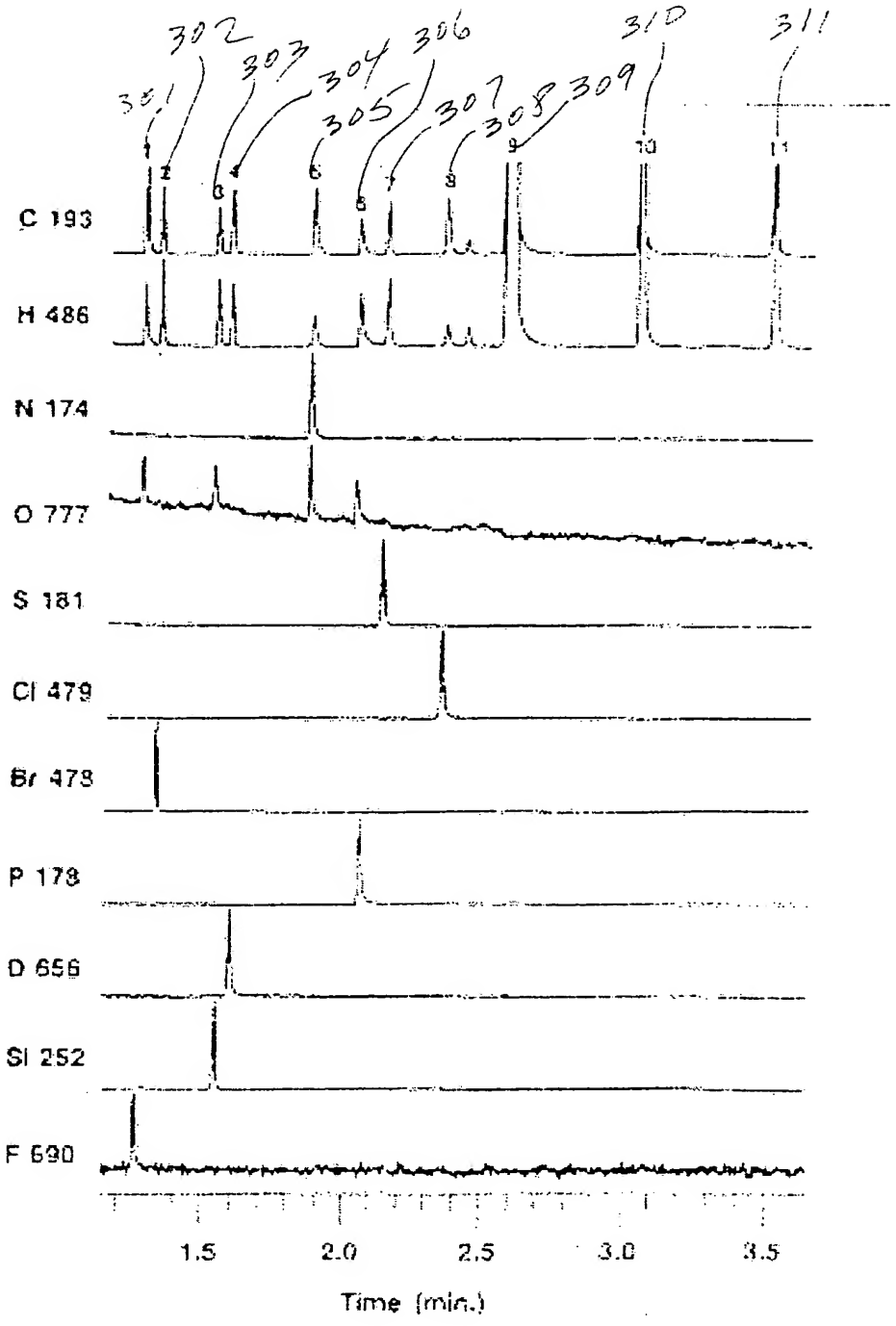

301
302
303
304
305
306
307
308
309
310
311
C 193
H 486
N 174
O 777
S 181
Cl 479
Br 478
P 178
D 656
Si 252
F 690
1.5
2.0
2.5
3.0
3.5
Time (min.)

FIGURE 11

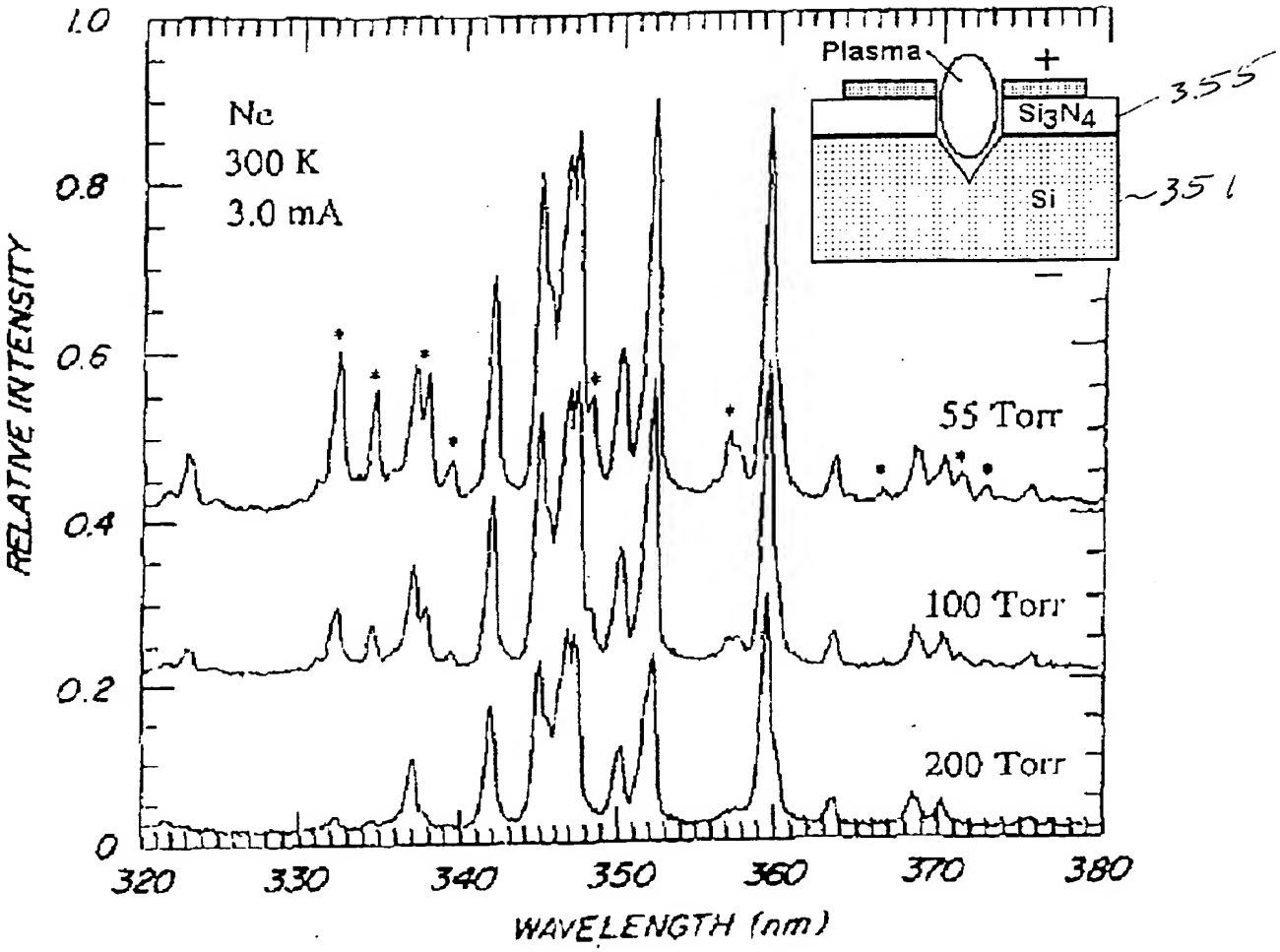

1.0
0.8
0.6
0.4
0.2
0
RELATIVE INTENSITY
Ne
300 K
3.0 mA
55 Torr
100 Torr
200 Torr
320
330
340
350
360
370
380
WAVELENGTH (nm)
Plasma
+
Si3N4
Si
355
351

FIGURE 12

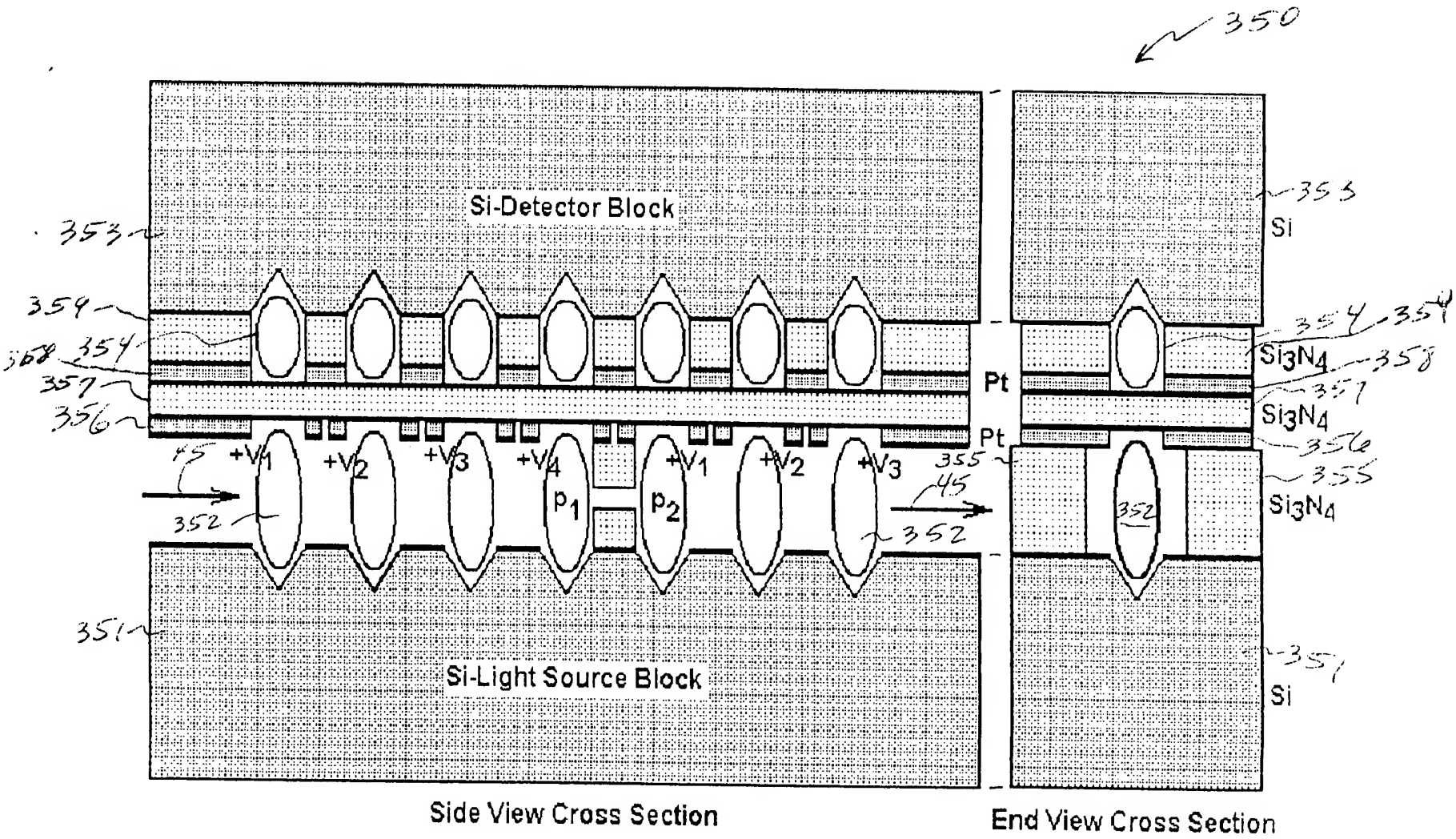

350
Si-Detector Block
353
354
358
354
357
356
Pt
Pt
+V1
+V2
+V3
+V4
+V1
+V2
+V3
45
45
352
352
352
p1
p2
355
351
Si-Light Source Block
Side View Cross Section
End View Cross Section
353
Si
354
354
Si3N4
358
357
Si3N4
356
355
Si3N4
351
Si

FIGURE 13

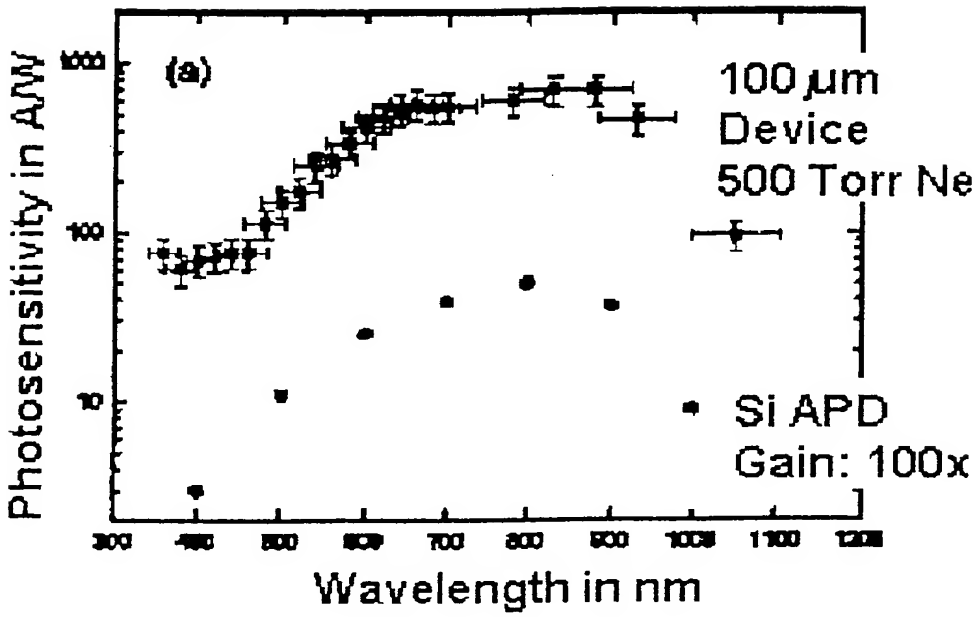
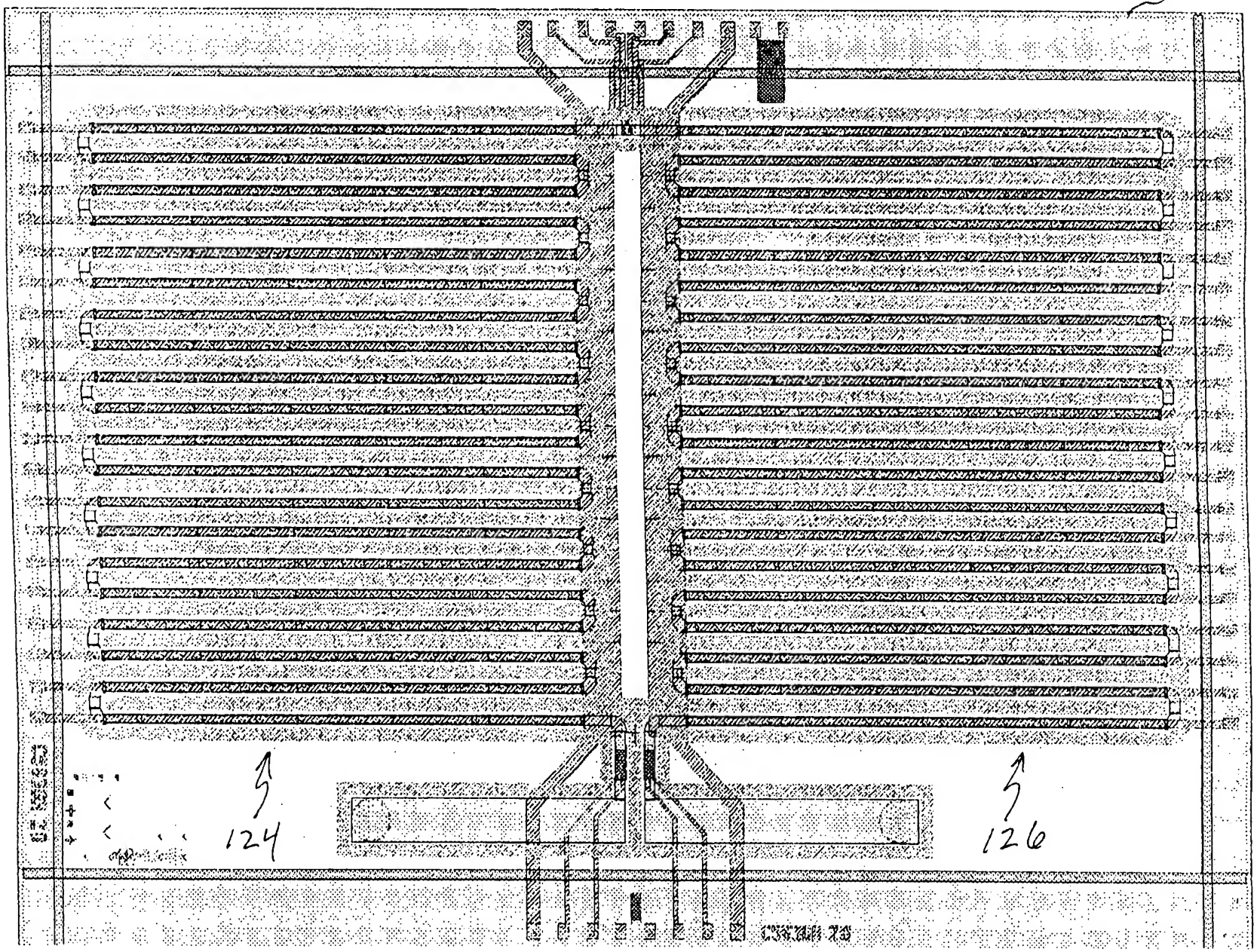

(a)
100 µm
Device
500 Torr Ne
Si APD
Gain: 100x
Photosensitivity in A/W
Wavelength in nm

FIGURE 14

Sensors: Flow and Temperature

401



20-Element Pre-Concentrator, Diff. TC, 20-Element Separator

FIGURE 1

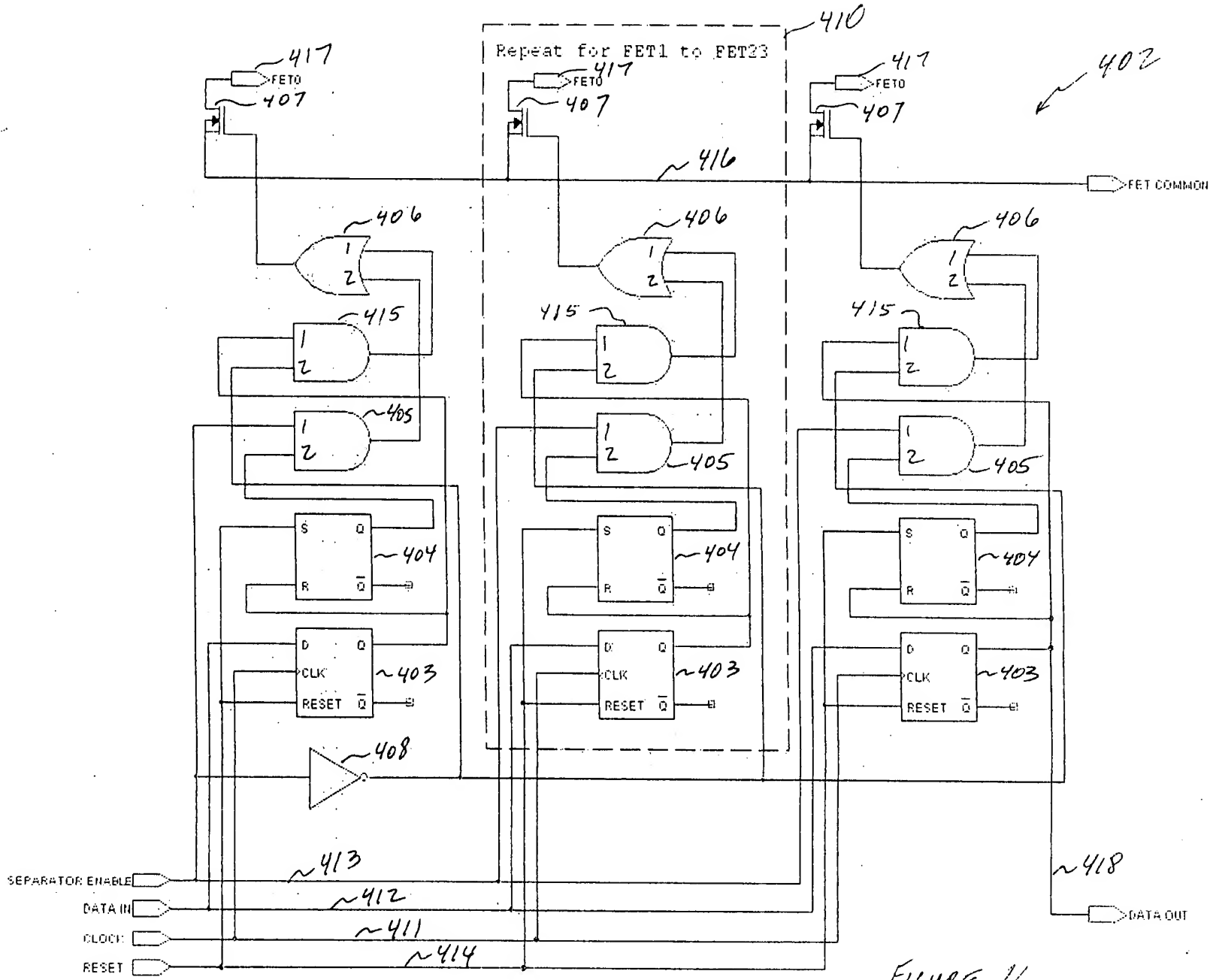

Repeat for FET1 to FET23
410
402
417
FET0
407
416
FET COMMON
406
415
405
404
403
408
413
412
411
414
418
DATA OUT
SEPARATOR ENABLE
DATA IN
CLOCK
RESET
S
R
D
CLK
RESET

FIGURE 16

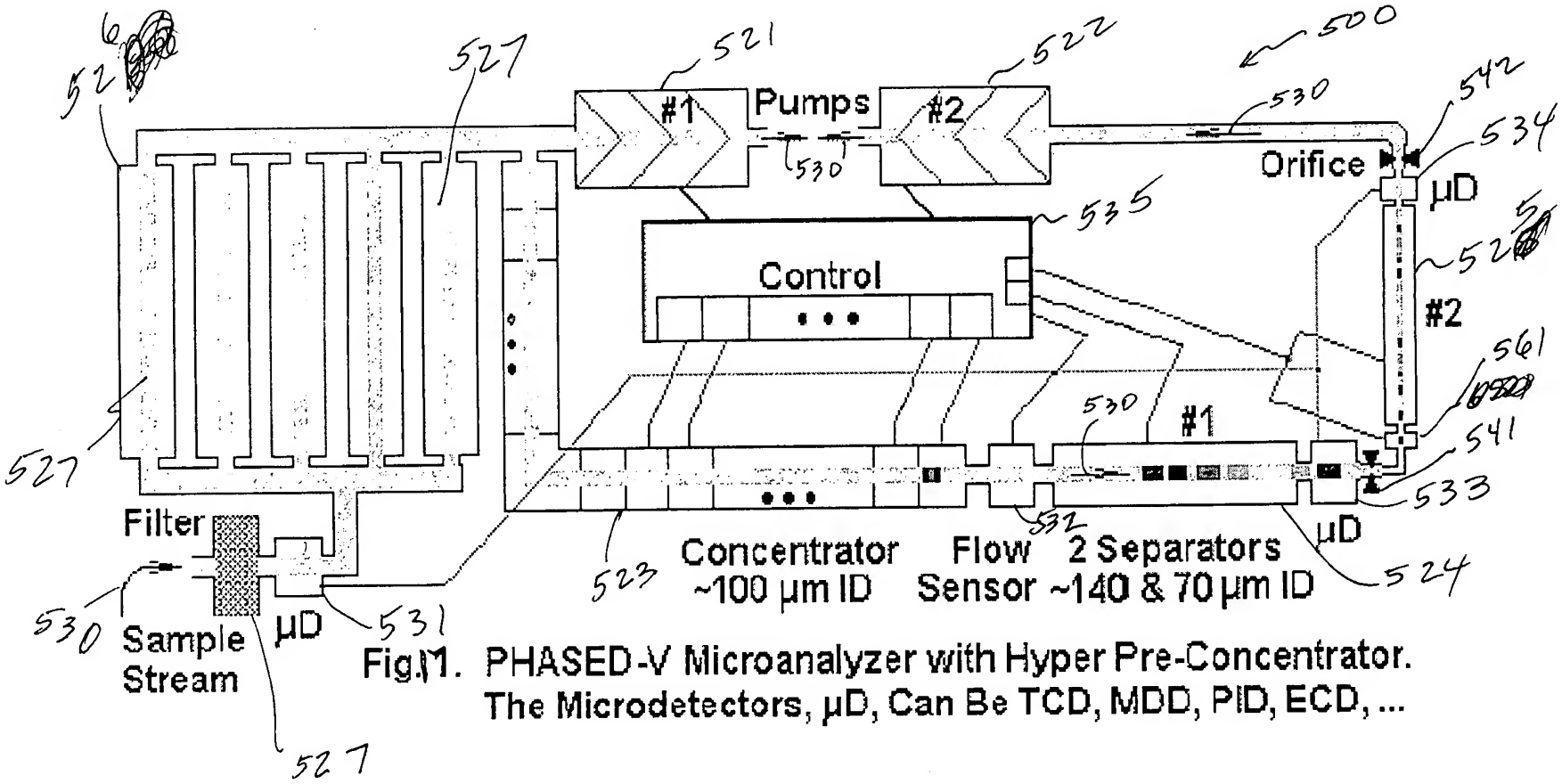


Fig.11. PHASED-V Microanalyzer with Hyper Pre-Concentrator.
The Microdetectors, μD, Can Be TCD, MDD, PID, ECD, ...

FIGURE 17

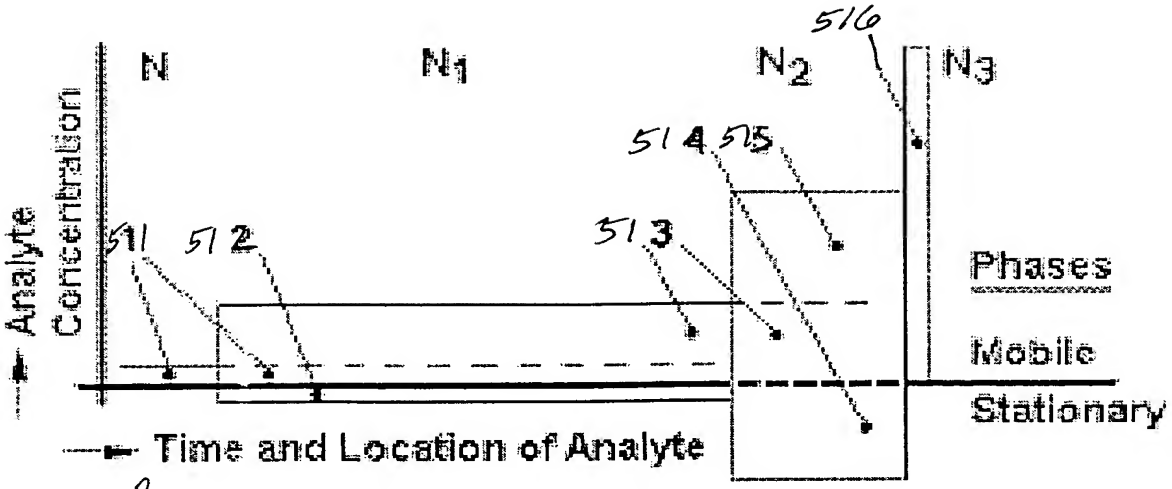


Fig. 18. Pre-Concentrated, Multi-Stage Pre-Concentration Concept and Examples

Analyte Masses = Film Length x Concentration

	N ppt	N_1 ppt	N_2 ppt	N_3 ppt
A	∞x1	500x100	5x10,000	1x 50,000
B	∞x1	1000x100	10x10,000	1x100,000
C	∞x1	5,000x100	50x10,000	1x500,000
D	∞x1	10,000x100	100x10,000	1x520,000+loss
E	∞x1	100,000x100	1,000x10,000	10x1,000,000 (10^7)

FIGURE 19

Pres.Drop at 100 cm/s, 100x100 μm

No. of Elem. N1 -	Length L cm	Pres. Drop Δp psi	Peak P. Q watts
50	0.5	2.629	20.5
505	0.1	5.311	41.3
1010	0.1	10.621	82.6

FIGURE 20

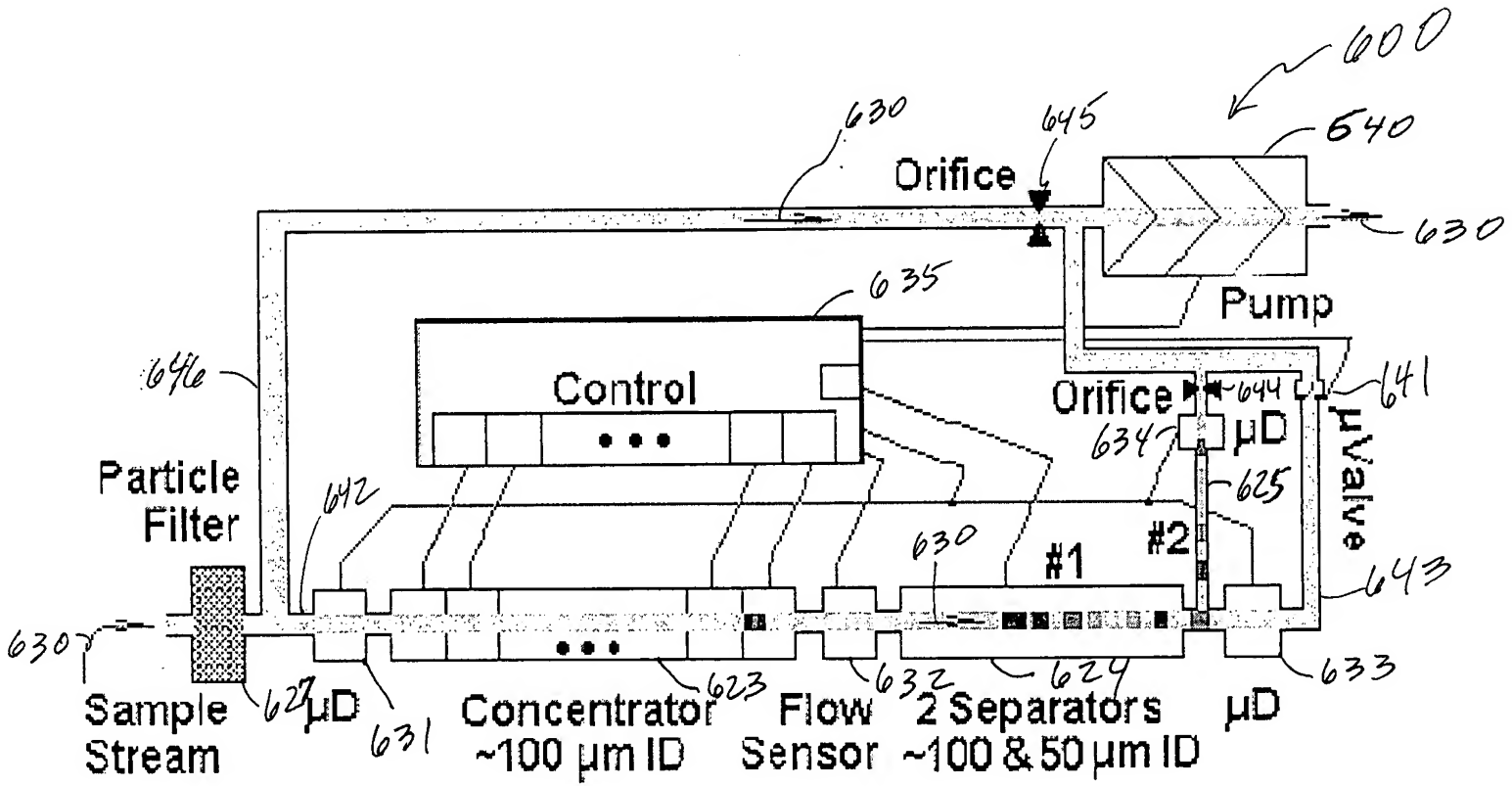


Fig. 21. GC-GC Microanalyzer Implemented on a PHASED Platform.
The Microdetectors, µD, Can Be TCD, MDD, PID, ECD, ...

FIGURE 21

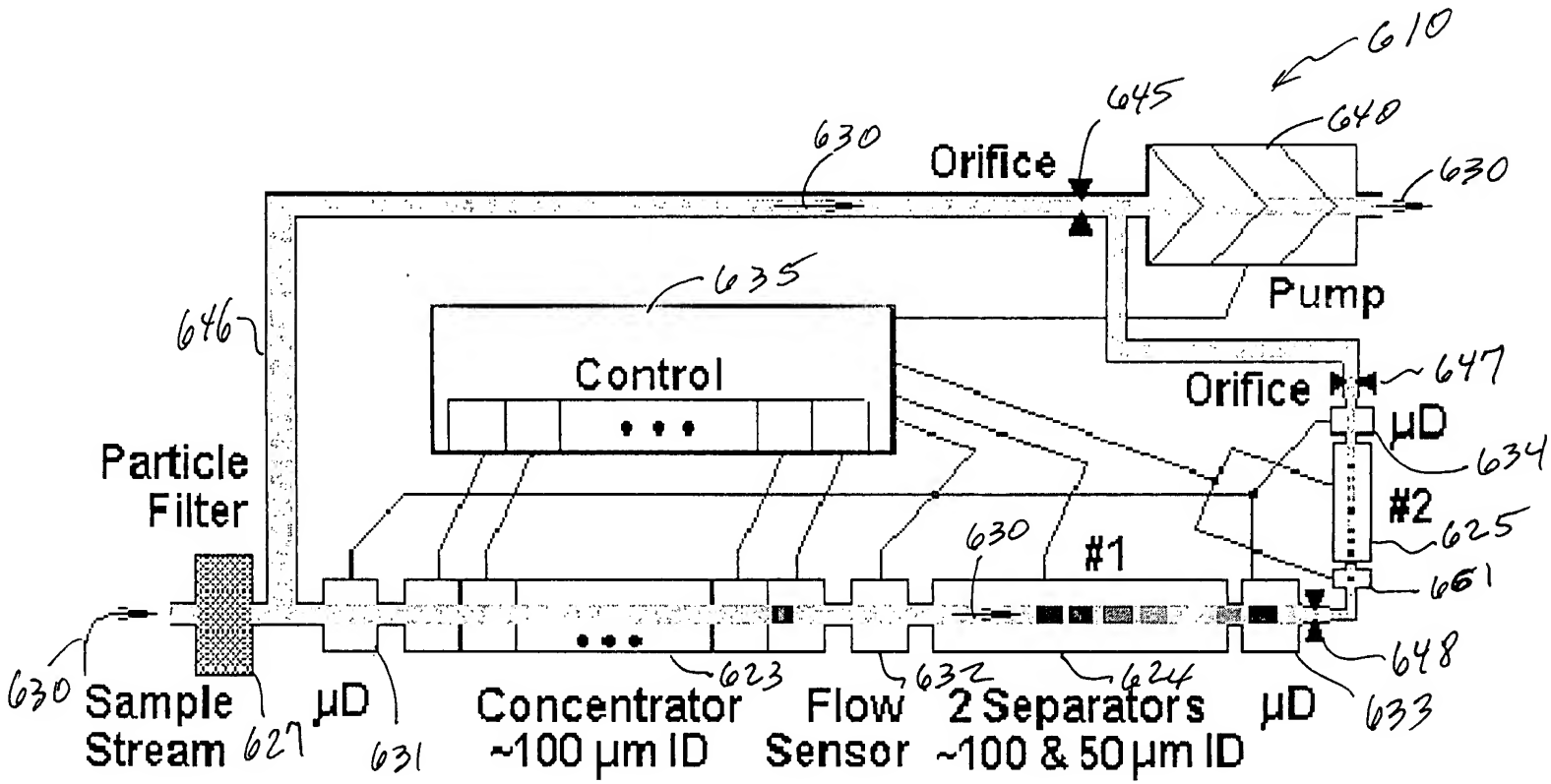


Fig. 22. GC-GC Microanalyzer Implemented on a PHASED Platform. The Microdetectors, μD, Can Be TCD, MDD, PID, ECD, ...

FIGURE 22

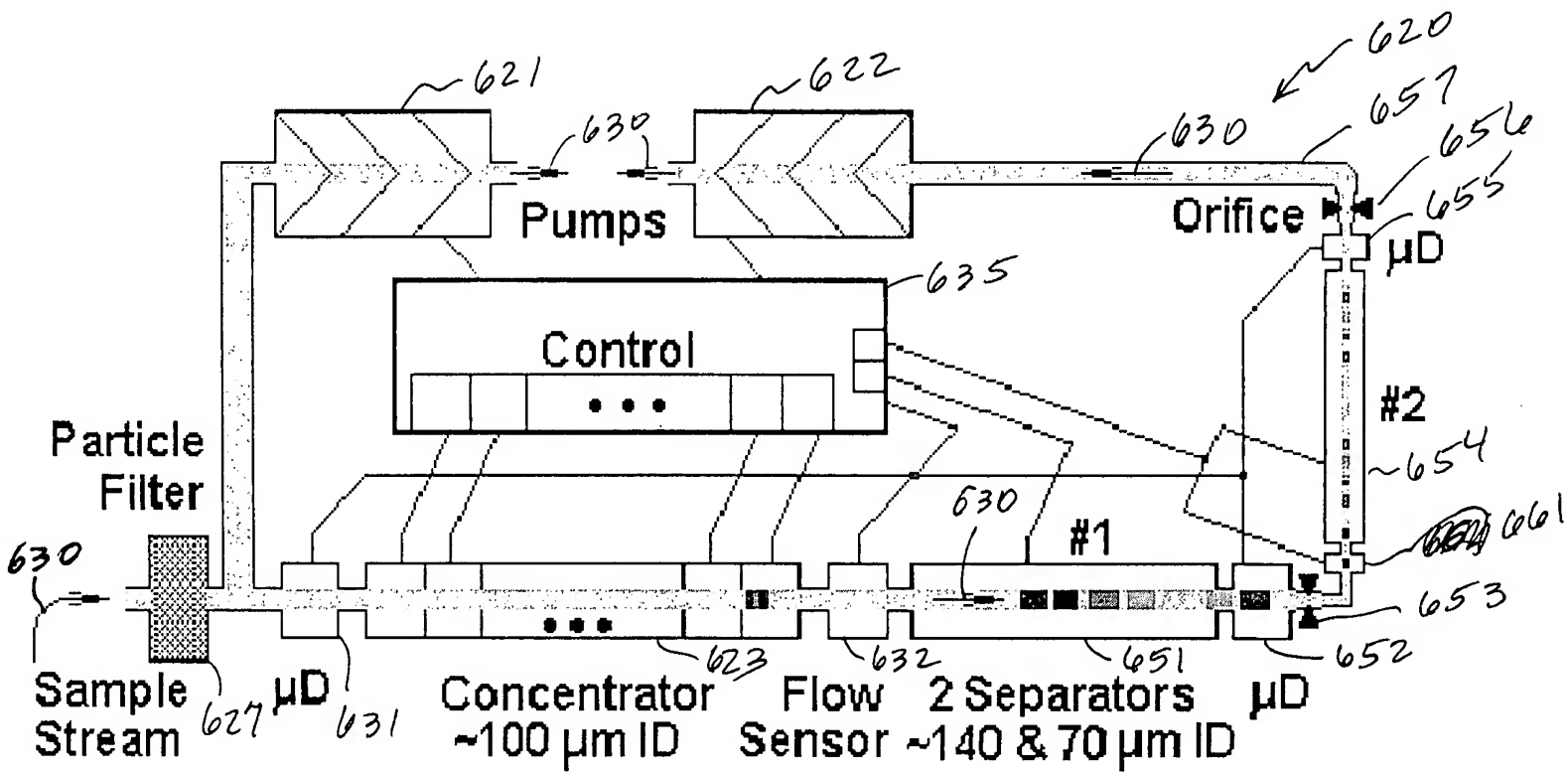


Fig. 23. GC-GC Microanalyzer Implemented on a PHASED Platform. The Microdetectors, μD, Can Be TCD, MDD, PID, ECD, ...

Table: Design of μGC-μGC System on the Basis of a PHASED Structure

	v in cm/s	ID in cm	L in cm	s in μm	ℓ in mm	V in cm3/min	Δp in psi	
μGC-1	50	0.014	25	1	5	0.588	0.671	
μGC-2	250	0.007	10	0.15	2.5	0.588	5.365	
			Half-Width	**k=6**	**k=0.2**	**k=2**	**k=2**	**k=0.2**
	v	**to**	**Δt**	**tR**	**v(optimal)**	**v(optimal)**	**R**	**ΔR(v-vo)**
	cm/s	**ms**	**ms**	**sec**	**cm/s**	**cm/s**	**-**	**%**
μGC-1	50	500	20	3.00	68.8	56	8.76	2.5
μGC-2	250	40	2	0.24	149.2	118	8.00	6.2

FIGURE 24